

The distribution of fused phalanges of the inner toe in the Accipitridae

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In certain members of the Accipitridae, the basal phalanges (1 and 2) of the inner toe (digit II) are fused to form a single functional unit. Although this condition has in the past been considered to have taxonomic significance, I have found that all the literature concerning the distribution of this character is either incomplete or inaccurate. As this appears to be a uniquely derived character that can perhaps be used to define a small, monophyletic group within the large and diverse family of hawks and eagles, it is of particular value because the intrafamilial systematics of the Accipitridae have been very poorly documented. Therefore, I conducted a comprehensive survey of the osteology of the bones of the inner toe in the Accipitridae in order to determine more precisely which taxa possess the fused condition of the phalanges.

MATERIAL EXAMINED

Most of the specimens I examined were skeletons in the collections of the National Museum of Natural History, Smithsonian Institution, Washington, D.C., and the American Museum of Natural History, New York. These were augmented by selected specimens from the Museum of Zoology, University of Michigan, Ann Arbor, and the Museum of Vertebrate Zoology, University of California, Berkeley. The sequence used below is that of Morony, Bock & Farrand (1975).

The following taxa were found to have the fused condition of the basal phalanges of the inner toe (number of individuals examined in parentheses): *Ictinia plumbea* (7), *I. mississippiensis* (1), *Milvus migrans* (16), *Haliaastur sphenurus* (1), *H. indus* (6), *Haliaeetus leucogaster* (4), *H. vocifer* (4), *H. leucocephalus* (34), *H. albicilla* (3), *H. pelagicus* (3), *Ichthyophaga nana* (= *humilis*) (1), *I. ichthyaetus* (1), *Busarellus nigricollis* (7—of which the phalanges were unfused in 1 specimen).

I examined at least one skeleton of each of the following species of Accipitridae in which the phalanges were not fused. *Aviceda cuculoides*, *Leptodon cayanensis*, *Cbondrohierax uncinatus*, *Henicopernis longicauda* (phalanges dissected from alcoholic specimen), *Pernis apivorus*, *Elanoides forficatus*, *Machaeobambus alcinus*, *Gampsonyx swainsonii*, *Elanus leucurus*, *E. caeruleus*, *Chelictinia riocourii* (phalanges taken from skin), *Rostrhamus sociabilis*, *Harpagus bidentatus*, *Lophoictinia isura*, *Hamirostra melanosternon*, *Gypobierax angolensis*, *Neophron percnopterus*, *Gypaetus barbatus*, *Necrosyrtes monachus*, *Gyps bengalensis*, *G. africanus*, *G. rueppellii*, *G. himalayensis*, *G. fulvus*, *Torgos tracheliotus*, *Sarcogyps calvus*, *Aegyptius monachus*, *Trigonoceps occipitalis*, *Circaetus gallicus*, *C. cinereus*, *Terathopius ecaudatus*, *Spilornis cheela*, *Polyboroides typus*, *Geranospiza caerulescens*, *Circus cyaneus*, *C. cinereus*, *C. pygargus*, *C. melanoleucus*, *Melierax metabates*, *M. canorus*, *M. gabar*, *Accipiter gentilis*, *A. melanoleucus*, *A. nisus*, *A. striatus*, *A. erythronemius*, *A. fasciatus*, *A. brevipes*, *A. badius*, *A. cooperii*, *A. bicolor*, *Urotriorchis macrourus*, *Butastur indicus*, *Kaupifalco monogrammicus*, *Leucopernis melanops*, *L. albicollis*, *Buteogallus anthracinus*, *B. urubitinga*, *Heterospizias meridionalis*, *Geranoaetus melanoleucus*, *Parabuteo unicinctus*, *Buteo nitidus*, *B. magnirostris*, *B. ridgwayi*, *B. lineatus*, *B. platypterus*, *B. swainsonii*, *B. galapagoensis*, *B. albicaudatus*, *B. polyosoma*, *B. poecliochrous*, *B. jamaicensis*, *B. buteo*, *B. lagopus*, *B. rufinus*, *B. hemilasius*, *B. regalis*, *B. auguralis*, *B. rufosulcus*, *Morphnus guianensis*, *Harpia harpyja*, *Pithechophaga jefferyi*, *Ictinaetus malayensis* (phalanges taken from skin), *Aquila pomarina*, *A. rapax*, *A. wahlbergi*, *A. gurneyi*, *A. chrysaetos*, *A. audax*, *A. verreauxii*, *Hieraetus fasciatus*, *Spizastur melanoleucus*, *Lophoaetus occipitalis*, *Spizastur*

(*cirrhatus*) *limnaeetus*, *S. nipalensis*, *S. tyrannus*, *S. ornatus*, *Stephanoaetus coronatus*, *Polemaetus bellicosus*.

There is also no fusion of phalanges in the Osprey *Pandion haliaetus* (Pandionidae).

The only genera for which no specimens of phalanges were available were *Dryotriorchis*, *Eutriorchis*, *Megatriorchis*, *Erythrotriorchis*, *Harpohaliaetus*, *Harpyopsis* and *Oroaetus*. Of these, *Megatriorchis* and *Erythrotriorchis* have been suggested as being congeneric with *Accipiter* by Amadon (1978). None of the others has been suggested to be closely related to genera in which the phalanges are known to be fused.

DISCUSSION

Shufeldt (1895) was the first to note the fused condition of the basal phalanges of digit II in the Accipitridae, reporting its occurrence in *Ictinia mississippiensis* and *Haliaeetus leucocephalus*. Friedmann (1950), doubtless following manuscript notes left by Ridgway, gave phalangeal fusion as a characteristic of his subfamily Milvinae or "true kites". Within the scope of that work, the only genera included in the Milvinae were *Harpagus*, *Ictinia*, and *Rostrhamus*. However, the phalanges are not fused in either *Harpagus* or *Rostrhamus*, whereas they are fused in *Haliaeetus*, a genus that Friedmann included in his Buteoninae. Brown & Amadon (1968: 20) essentially followed Friedmann and compounded the errors by stating that the fusion took place in the phalanges of the middle toe, rather than the inner toe, as is actually the case. The genera that they implied as possessing fused phalanges were *Rostrhamus*, *Harpagus*, *Ictinia*, *Lophoictinia*, *Hamirostra*, *Milvus*, and *Haliaeetus*, as well as the genera *Haliaeetus* and *Ichthyophaga*. Although Brown & Amadon did not employ formal designations for their subdivisions of the Accipitridae, they considered the first group of genera to be a subgroup of the "kites", whereas the last two genera were deemed to represent a different group, the "fish eagles". As seen in the list of materials above, 4 of the genera in their milvine subgroup of kites do not possess fused phalanges. In his treatment of morphology of the Falconiformes, Jollie (1977: 28) stated that "of the feet examined only those of *Milvus*, *Ictinia*, *Haliaeetus*, and *Ichthyophaga* showed fusion . . . The fusion in *Haliaeetus* may be incomplete with only the under surface involved, whereas the joint appears more or less normal above." These observations are correct as far as they go, the omissions being *Haliaeetus* and *Busarellus*.

Deferring discussion of *Busarellus* (below), the genera that actually do have fused phalanges are all presently considered to be fairly closely related. The sequence *Ictinia*, *Lophoictinia*, *Hamirostra*, *Milvus*, *Haliaeetus*, *Haliaeetus*, and *Ichthyophaga*, used by Brown & Amadon (1968) and Morony *et al.* (1975), contains only 2 genera, *Lophoictinia* and *Hamirostra*, in which the phalanges are not fused. These 2 genera have been associated with the others only on very superficial similarities. For instance, Amadon (1978: 115) stated that *Lophoictinia* "looks much like a *Milvus*" but at the same time he remarked that *Hamirostra* "is aberrant for a kite in its buteonine proportions" and that *Lophoictinia* and *Hamirostra* "probably represent some earlier incursion of milvine stock into Australia and are not particularly close to either *Milvus* or *Haliaeetus*". The absence of fused phalanges in *Lophoictinia* and *Hamirostra* suggests that better supporting evidence is needed before a relationship between these endemic Australian genera and the milvine kites can be claimed.

Milvus and *Haliaeetus* appear to be closely related, having traditionally been separated only by minor features of external morphology (Amadon 1978). The "fish eagles" *Haliaeetus* and *Ichthyophaga* have long been considered to be related to *Milvus* and *Haliaeetus* (Ridgway 1873, Brown & Amadon 1968). Of the taxa with fused phalanges, *Ictinia* is the least like the others in appearance and habits, although no evidence seems to be available to ally it more closely with any other genus or group of genera. The fused condition of the phalanges is thus correlated neither with size nor with feeding habits, being found in small kites such as *Ictinia* as well as in some of the largest of the eagles, and in insectivorous, in scavenging, and in highly piscivorous species. Because the fusion of the phalanges may at times be confined to the ventral surface, it would appear that this is an adaptation to prevent hyperextension at the base of the inner toe; but it is not clear why this would be of advantage to the particular species possessing this adaptation, as opposed to other raptors.

THE RELATIONSHIP OF *Busarellus*

An unexpected revelation in this study was the discovery of fused phalanges in the Black-collared Hawk or Fishing Buzzard *Busarellus nigricollis*. This distinctive species ranges from southern Mexico, through much of South America and is specialized for catching fish, even to having prickly spicules on the soles of the feet in the manner of ospreys (*Pandion*). Brown & Amadon (1968: 565) express the current view of the relationships of this singular bird as follows:

"A specialized member of the group of neotropical sub-buteonines which includes *Heterospizias*, *Buteogallus* and *Parabuteo*.

Ridgway thought the genus was very isolated and related to the Australian kite (*Hamirostra*). We assume, however, that the resemblance to that genus is superficial and the resemblance to the neotropical genera just mentioned is real."

From a review of the literature, it appears to me that much of the sequence of genera of New World Accipitridae now in use is derived from the early, preliminary work of Ridgway (1873, 1876, and other studies), with very little of substance having been added subsequently. In one of his first ventures at a classification of the diurnal raptors, Ridgway (1873) placed *Busarellus* (then known as *Ichthyoborus*) in his "group Haliaeiti" along with *Haliaeetus*, *Haliaeetus*, and *Milvus*. Three years later, Ridgway (1876) placed *Busarellus* after *Herpetotheres* (a member of the Falconidae), *Heterospizias*, and *Buteogallus*, and before *Harpia*, *Morphnus*, and *Gampsonyx* (a kite related to *Elanus*). It does not seem that Ridgway intended any particular degree of relationship to be implied by the sequence he used in this work. Although he characterized *Busarellus* as having the "general form and appearance of *Buteogallus aequinoctialis*" (Ridgway 1876: 142), this was evidently intended for descriptive purposes only. While noting some superficial similarities to *Pandion*, he went on to say that *Busarellus* "is much more nearly related to the heliaetine groups, especially to the remarkable Australian genus *Gypoictinia* [= *Hamirostra*], from which, however, it is widely distinct, as it is from all American genera". Thus, on 2 occasions Ridgway (1873, 1876) clearly stated that he thought *Busarellus* was related to *Haliaeetus* and its presumed allies. I believe that this is probably the last opinion on the matter to be founded on anything other than tradition. Other authors seem merely to have adopted

much of Ridgway's sequence in preference to his stated beliefs. Therefore, most subsequent works (e.g. Swann 1922, Peters 1931, Hellmayr & Conover 1949, Friedmann 1950, Brown & Amadon 1968) list *Busarellus* somewhere in the vicinity of *Buteogallus*. To my knowledge, no characters have been published to justify this arrangement.

In plumage, *Busarellus* does not closely resemble any of the genera with which it is presently associated, but its white head streaked with dusky, overall chestnut coloration, and blackish remiges are reminiscent of the Brahminy Kite *Haliastur indus*, on one hand, and *Haliaeetus*, particularly *H. vocifer*, on the other. It should be noted, however, that the transverse barring of the thighs and venter in juveniles of *Busarellus* are not found in *Milvus*, *Haliastur*, or *Haliaeetus*, and could be cited as being similar to such taxa as *Buteogallus* and *Heterospizias*.

In the sequence *Milvus-Haliastur-Haliaeetus-Ichthyophaga*, there is an increasing affinity among the species for aquatic environments as well as an increasing dependence upon fish in the diet. Although the species of *Buteogallus* frequent swampy areas and prey largely or entirely on crabs, the highly specialized fish-catching behaviour of *Busarellus* seems more similar to that in some of the species of *Haliaeetus*.

The strongest evidence for an association of *Busarellus* with the *Milvus-Haliaeetus* assemblage is the fusion of the phalanges of the inner toe, present in 6 of the 7 skeletons examined. The exceptional individual did not seem to be misidentified, nor was it clearly a juvenile bird. No variation was observed in this character in any of the other species that possess it, although no ontogenetic series was available by which to determine exactly when the fusion takes place during development. If the specimen of *Busarellus* with unfused phalanges is merely an abnormal individual, there is not sufficient material available to ascertain how frequently this abnormality occurs.

It is probably safe to conclude that the species of *Milvus*, *Haliastur*, *Haliaeetus* and *Ichthyophaga* constitute a natural assemblage. Phalangeal fusion, plumage, and feeding habits suggest that *Busarellus* may belong with this assemblage, whereas phalangeal fusion appears to be the only character yet known to indicate that *Ictinia* also belongs with this group. Justification for putting *Busarellus* and *Ictinia* with the milvines requires confirmation by other characters, but the same is true of the placement of almost any of the genera of Accipitridae, a family in dire need of a comprehensive systematic revision that is thoroughly grounded in comparative anatomy of internal structures. It is hoped that knowing the true distribution of phalangeal fusion in the family will further this end.

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A new subspecies of *Serinus estherae* (Carduelidae) from Sulawesi

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The avifauna of Sulawesi, formerly known as Celebes, has been studied extensively by Stresemann (1939-1941, *J. Orn.* Vols. 87-89). Since his biogeographical and systematic survey of the birds of this island, based on a collection gathered during an expedition by G. Heinrich from 1930 to 1932, little additional information on the birdlife of Sulawesi has come to our knowledge.

In August 1980, Mr. Christian Krause, one of our collectors, visited the southern ridge of Mt. Rantekombola, Sulawesi (3°23'S, 120°02'E). His field headquarters was situated above treeline at an elevation of 2300 m, where the vegetation is dominated by extended grassland with scattered shrubs. Here he observed small flocks (up to 6 individuals) of *Serinus estherae*, a carduelid seedeater formerly unknown on the island. According to his observations *S. estherae* was restricted to open habitats between 2000 and 3000 m around Mt. Rantekombola. One specimen was collected and is now in the bird collection of the Zoologisches Forschungsinstitut und Museum A. Koenig (ZFMK) in Bonn, FRG. It constitutes a new race:

Serinus estherae renatae subsp. nov.

Type: Adult, probably male; Mt. Rantekombola, Sulawesi, elevation 2300 m, 6 August 1980; collected by Christian Krause. Reg. No. Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn 81.563.

Diagnosis: *S. e. renatae* differs mainly from all other subspecies of *S. estherae* by its heavier and wider, cone-shaped beak (see Fig. 1 and Table 1). Otherwise it is similar to *S. e. vanderbilti* de Schauensee (of which *S. e. ripleyi* Chasen is a